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## ABSTRACT

This document examines the origins and content of Ohio's Automobile Technician Training Certification Program, which is designed to improve the quality of training offered at secondary and postsecondary schools throughout Ohio. The document begins with a brief overview of the certification program, which is under the oversight of the Board of the National Institute for Automotive Service Excellence and under direct supervision of the National Automotive Technicians Education Foundation. The remainder of the document lists the competencies and key indicators of the 11 units of study comprising the automotive technician program. The unit titles are as follows: (1) orientation to the automotive industry; (2) basic shop and safety practices; (3) preventive maintenance; (4) suspension and steering; (5) brakes; (6) electrical and electronic systems; (7) engine performance; (8) engine repair; (9) automatic transmission and transaxle; (10) manual drive train and axles; and (11) heating and air conditioning. Units 3-11 address the specific competencies required for inspecting, diagnosing, and repairing or replacing defective vehicle parts. Units 1 and 2 address more generic competencies, including the following: define the industry; determine skills needed to work in the automotive industry; use personal safety equipment; maintain a safe work environment; protect workers from ergonomic injuries; access needed information using available references and resources; and provide customer service. (MN)

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## Overview

### Automotive Technician

Anyone whose car or light truck has broken down knows the importance of the jobs of automotive service technicians and mechanics. The ability to diagnose the source of a problem quickly and accurately - a most valuable skill - requires good reasoning ability and a thorough knowledge of automobiles.

The work of automotive service technicians and mechanics has evolved from simply mechanical to high technology. Today integrated electronic systems and complex computers run vehicles and measure their performance while on the road. Automotive service technicians have developed into diagnostic, high-tech problem solvers. Technicians must have an increasingly broad base of knowledge about how vehicles; complex components work and interact, as well as the ability to work with electronic diagnostic equipment and computer-based technical reference materials.

Auto service technicians and mechanics use these high-tech skills to inspect, maintain, and repair automobiles and light trucks with gasoline engines. The increasing sophistication of automotive technology now relies on workers who can use computerized shop equipment and work with electronic components, while maintaining their skills with traditional hand tools. Because of these changes in the occupation, workers are increasingly called "automotive service technicians," and the title "mechanic" is being used less frequently.

During routine service inspections, technicians test and lubricate engines and other major components. In some cases, the technician may repair or replace worn parts before they cause breakdowns that could damage critical components of the vehicle.

Service technicians use a variety of tools in their work. They use power tools, such as pneumatic wrenches to remove bolts quickly, machine tools like lathes and grinding machines to rebuild brakes, welding and flame-cutting equipment to remove and repair exhaust systems, and jacks and hoists to lift cars and engines. They also use common hand tools like screwdrivers, pliers, and wrenches to work on small parts and hard-to-reach places.

Automotive technology is rapidly increasing in sophistication, and most training authorities strongly recommend that persons seeking automotive service technician jobs complete a formal training program in high school or in a post secondary vocational school. Automotive Technician programs at Ohio's Career, Technical and Adult Vocational Schools are certified programs. The Board of the National Institute for Automotive Service Excellence (ASE) is the body responsible for the Automobile Technician Training Certification Program. ASE will grant certification to programs that comply with the evaluation procedure, meet established standards and adhere to the policies for certification. The Certification Program is under the direct supervision of the Board of Trustees of the National Automotive Technicians Education Foundation (NATEF) and such personnel designated or employed by the Foundation. The purpose of the Automobile Technician Training Certification Program is to improve the quality of training offered at the secondary and post-secondary levels. The following four areas are required for minimum certification or recertification and Ohio Automotive Technician students are ASE certified in all four:

- Brakes
- Electrical/Electronic Systems
- Engine Performance
- Suspension and Steering

Some programs offer instruction and certification in:

- Automatic Transmission and Transaxle
- Engine Repair
- Heating and Air Conditioning
- Manual Drive Train and Axles

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## Units Automotive Technician

1. Orientation to the Automotive Industry
2. Basic Shop and Safety Practices
3. Preventive Maintenance
4. Suspension and Steering\*\*
5. Brakes\*\*
6. Electrical and Electronic Systems\*\*
7. Engine Performance\*\*
8. Engine Repair (Optional Unit)
9. Automatic Transmission and Transaxle (Optional Unit)
10. Manual Drive Train and Axles (Optional Unit)
11. Heating and Air Conditioning (Optional Unit)

\* Ohio Professional Committee raised the level on some competencies

\*\*Required by NATEF for ASE program certification in state of Ohio

\*\*\*NATEF/ASE certification requires passing a percentage of competencies in each level (i.e., P-1 95%, P-2 80%, P-3 50%)

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## Automotive Technician

### Unit 1: Orientation to the Automotive Industry

#### Competency 1.1: Define the industry

##### Key Indicators:

- 1.1.1 Present an overview of the automotive industry
- 1.1.2 Identify the professional and/or trade associations related to the automotive industry
- 1.1.3 Identify areas of specialization and related occupations within the automotive industry
- 1.1.4 Identify the employment opportunities in the automotive industry

#### Competency 1.2: Determine skills needed to work in the automotive industry

##### Key Indicators:

- 1.2.1 Match automotive occupational job titles with qualifications and responsibilities
- 1.2.2 Identify education and training required to work in the various automotive careers
- 1.2.3 Describe the kinds of work techniques, processes and procedures a typical automotive worker might be called on to perform

### Unit 2: Basic Shop and Safety Practices

#### Competency 2.1: Use personal safety equipment

P-1

##### Key Indicators:

- 2.1.1 Wear eye and ear protection in accordance with Occupational Safety and Health Administration (OSHA) standards
- 2.1.2 Wear prescribed foot and hand protection
- 2.1.3 Wear clothing in accordance with OSHA standards
- 2.1.4 Remove jewelry in accordance with shop policy
- 2.1.5 Secure long hair
- 2.1.6 Practice established lifting techniques
- 2.1.7 Maintain personal protective equipment

#### Competency 2.2: Respond to fire situations

P-1

**Key Indicators:**

- 2.2.1 Locate fire exits and alarms
- 2.2.2 Follow established evacuation procedures
- 2.2.3 Locate fire blankets and first-aid kits
- 2.2.4 Identify types of fires
- 2.2.5 Demonstrate use of fire extinguishers in accordance with established procedures
- 2.2.6 Maintain operability of fire extinguishers in accordance with established procedures
- 2.2.7 Follow established reporting procedures

**Competency 2.3: Demonstrate general safety practices****P-1****Key Indicators:**

- 2.3.1 Interpret shop safety policies and procedures
- 2.3.2 Comply with shop safety plan
- 2.3.3 Respond to emergencies and injuries in accordance with facility requirements (cardiopulmonary resuscitation, apply basic first aid, etc.)
- 2.3.4 Report injuries to supervisor
- 2.3.5 Complete written safety and injury reports
- 2.3.6 Practice established procedures for jacking, lifting, moving and blocking vehicles and shop equipment
- 2.3.7 Check brakes before moving vehicular equipment
- 2.3.8 Demonstrate safe driving practices according to shop procedures
- 2.3.9 Practice established safety procedures for using chains and straps
- 2.3.10 Maintain hand tools in safe operating condition
- 2.3.11 Maintain shop equipment in safe operating condition in accordance with manufacturers'/OSHA specifications
- 2.3.12 Comply with lock-out/tag-out procedures for defective equipment
- 2.3.13 Identify offenses that could result in unsafe working conditions leading to disciplinary actions (horseplay, substance abuse theft, etc.)

**Competency 2.4: Maintain safe work environment****P-1****Key Indicators:**

- 2.4.1 Maintain clean work environment
- 2.4.2 Follow Environmental Protection Agency (EPA) regulations for air filtering and ventilation of the work environment
- 2.4.3 Identify sources of contamination and other hazards
- 2.4.4 Contain sources of air-borne contamination and other hazards (e.g., asbestos)
- 2.4.5 Follow established safety procedures for the draining, removal and storage of gasoline tanks
- 2.4.6 Follow safety rules for handling flammable liquids
- 2.4.7 Follow EPA regulations for the storage, use, recycling and disposal of hazardous materials
- 2.4.8 Analyze liability associated with hazardous material disposal
- 2.4.9 Respond to hazardous chemical spills
- 2.4.10 Report unsafe practices and conditions
- 2.4.11 Correct unsafe practices and conditions
- 2.4.12 Interpret OSHA Right-to-Know law
- 2.4.13 Interpret Material Safety Data Sheets (MSDS)
- 2.4.14 Identify resources for determining employee's rights to information

**Competency 2.5: Protect workers from ergonomic injuries**

**Key Indicators:**

- 2.5.1 Identify cause and effect of work practices to prevent ergonomic (operator fatigue, discomfort) injuries
- 2.5.2 Identify repetitive motion activities that might cause injuries

**Competency 2.6: Access needed information using available**

**references and resources**

**P-1**

**Key Indicators:**

- 2.6.1 Identify available resources (manufacturers' specifications, videos, computer programs, service bulletins, service manuals, parts manuals, company procedure manuals, manufacturer's toll-free numbers, worldwide web sites and estimating guides)
- 2.6.2 Identify reference materials and resources appropriate for given task
- 2.6.3 Locate needed information within given references and resources
- 2.6.4 Interpret reference materials and resources, including text, charts, graphs, schematics, illustrations and tables

**Competency 2.7: Demonstrate use of basic academic knowledge and tools**

**P-1**

**Key Indicators:**

- 2.7.1 Perform basic math functions (addition, subtraction, multiplication and division of whole numbers, fractions and decimals)
- 2.7.2 Identify tools and their uses
- 2.7.3 Select tools appropriate for given task
- 2.7.4 Apply metric and English measurement skills
- 2.7.5 Measure inside/outside diameters, lift, end-play, run-out and backlash

**Competency 2.8: Provide customer service**

**P-1**

**Key Indicators:**

- 2.8.1 Prepare service orders with customer input
- 2.8.2 Communicate solutions to customers
- 2.8.3 Interpret Vehicle Identification Number (VIN) codes
- 2.8.4 Complete service or work orders
- 2.8.5 Document services recommended and/or performed
- 2.8.6 Ensure readability of documentation (legible writing, accurate spelling, etc.)
- 2.8.7 Identify consumer rights resources
- 2.8.8 Utilize appropriate vehicle repair protective coverings (i.e., floor mats, fender covers, seat covers, steering wheel covers)

**Competency 2.9: Acquire parts**

**P-2**

**Key Indicators**

- 2.9.1 Collect necessary information (make, model year, VIN option codes)
- 2.9.2 Convey information to parts person
- 2.9.3 Check for price
- 2.9.4 Check for availability
- 2.9.5 Confirm that the part received is correct

## **Unit 3: Preventive Maintenance**

### **Competency 3.1: Review vehicle maintenance schedules**

**P-2**

#### **Key Indicators:**

- 3.1.1 Verify mileage
- 3.1.2 Verify previous maintenance
- 3.1.3 Verify maintenance needs
- 3.1.4 Prepare estimates
- 3.1.5 Communicate to customers the need for and importance of preventive maintenance

### **Competency 3.2: Inspect and replace as needed vehicle components and systems**

**P-1**

#### **Key Indicators:**

- 3.2.1 Check and repair vehicle warning lights as needed
- 3.2.2 Change oil and filters and lubricate vehicle
- 3.2.3 Flush system; refill system with recommended coolant; bleed system (follow recommended disposal guidelines)
- 3.2.4 Inspect and repair vehicle tires as needed
- 3.2.5 Rotate tires according to manufacturer's recommendations
- 3.2.6 Examine and repair hoses and belts as needed
- 3.2.7 Inspect and repair exhaust system as needed
- 3.2.8 Examine and repair filters (fuel, air, oil) as needed
- 3.2.9 Inspect and repair brake system as needed
- 3.2.10 Inspect and repair steering linkages as needed
- 3.2.11 Inspect and repair coolant system as needed
- 3.2.12 Inspect and repair fluid condition and levels as needed
- 3.2.13 Check and repair the presence of leaks as needed
- 3.2.14 Examine and repair exterior lights as needed
- 3.2.15 Examine and replace seat belts as needed
- 3.2.16 Inspect and repair wipers and washers as needed
- 3.2.17 Inspect and repair (checking for body damage; wheel cover condition; and integrity of glass, hinges, locks, and handles) exterior and interior condition of vehicle **P-3**

## **Unit 4: Suspension and Steering\*\***

### **Competency 4.1: Perform general suspension and steering systems diagnosis**

#### **Key Indicators:**

- 4.1.1 Identify and interpret suspension and steering concern; determine necessary action **P-1**
- 4.1.2 Research applicable vehicle and service information such as suspension and steering system operation, vehicle service history, service precautions and technical bulletins **P-1**
- 4.1.3 Locate and interpret vehicle and major component identification numbers (VIN, vehicle certification labels, calibration decals) **P-1**

### **Competency 4.2: Perform steering systems diagnosis and repair**

**Key Indicators:**

|        |                                                                                                                                                                    |     |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 4.2.1  | Disable and enable Supplemental Restraint System (SRS) in accordance with manufacturer's procedures                                                                | P-1 |
| 4.2.2  | Remove and replace steering wheel; center/time supplemental restraint system (SRS) coil in accordance with manufacturer's procedures                               | P-1 |
| 4.2.3  | Diagnose steering column noises, looseness, and binding concerns (including tilt mechanisms); determine necessary action                                           | P-2 |
| 4.2.4  | Diagnose power steering gear (non-rack and pinion) binding, uneven turning effort, looseness, hard steering and fluid leakage concerns; determine necessary action | P-2 |
| 4.2.5  | Diagnose power steering gear (rack and pinion) binding, uneven turning effort, looseness, hard steering, and fluid leakage concerns; determine necessary action    | P-3 |
| 4.2.6  | Inspect steering shaft universal-joints(s), flexible coupling(s), collapsible column, lock cylinder mechanism, and steering wheel; perform necessary action        | P-2 |
| 4.2.7  | Adjust manual or power non-rack and pinion worm bearing preload and sector lash                                                                                    | P-3 |
| 4.2.8  | Remove and replace manual or power rack and pinion steering gear; inspect mounting bushings and brackets                                                           | P-1 |
| 4.2.9  | Inspect and replace manual or power rack and pinion steering gear inner tie rod ends (sockets) and bellows boots                                                   | P-1 |
| 4.2.10 | Inspect power steering fluid levels and condition                                                                                                                  | P-1 |
| 4.2.11 | Flush, fill and bleed power steering system                                                                                                                        | P-2 |
| 4.2.12 | Diagnose power steering fluid leakage; determine necessary action                                                                                                  | P-2 |
| 4.2.13 | Remove, inspect, replace and adjust power steering pump belt                                                                                                       | P-1 |
| 4.2.14 | Remove and reinstall power steering pump                                                                                                                           | P-3 |
| 4.2.15 | Remove and reinstall power steering pump pulley and belt alignment                                                                                                 | P-3 |
| 4.2.16 | Inspect and replace power steering hoses and fittings                                                                                                              | P-2 |
| 4.2.17 | Inspect and replace pitman arm, relay (centerlink/intermediate) rod, idler arm and mountings and steering linkage damper                                           | P-2 |
| 4.2.18 | Inspect, replace and adjust tie rod ends (sockets), tie rod sleeves and clamps                                                                                     | P-1 |
| 4.2.19 | Test and diagnose and adjust components of electronically controlled steering systems; determine necessary action                                                  | P-3 |

**Competency 4.3: Perform suspension systems diagnosis and repair****Key Indicators:****Front Suspension**

|        |                                                                                                                               |     |
|--------|-------------------------------------------------------------------------------------------------------------------------------|-----|
| 4.3.1  | Diagnose short and long arm suspension system noises, body sway and uneven riding height concerns; determine necessary action | P-1 |
| 4.3.2  | Diagnose strut suspension system noises, body sway and uneven riding height concerns; determine necessary action              | P-1 |
| 4.3.3  | Remove, inspect, and install upper and lower control arms, bushings, shafts and rebound bumpers                               | P-3 |
| 4.3.4  | Remove, inspect, install and adjust strut (compression/tension) rods and bushings                                             | P-2 |
| 4.3.5  | Remove, inspect and install upper and lower ball joints on short and long arm suspension systems                              | P-2 |
| 4.3.6  | Remove, inspect and install steering knuckle assemblies                                                                       | P-2 |
| 4.3.7  | Remove, inspect, and install short and long arm suspension system coil springs and spring insulators                          | P-2 |
| 4.3.8  | Remove, inspect, install and adjust suspension system torsion bars; inspect mounts                                            | P-3 |
| 4.3.9  | Remove, inspect and install stabilizer bar bushings, brackets and links                                                       | P-2 |
| 4.3.10 | Remove, inspect, and install strut cartridge or assembly, strut coil spring,                                                  | P-1 |

|        |                                                                                                  |     |
|--------|--------------------------------------------------------------------------------------------------|-----|
| 4.3.11 | insulator (silencers) and upper strut bearing mount<br>Lubricate suspension and steering systems | P-2 |
|--------|--------------------------------------------------------------------------------------------------|-----|

#### **Rear Suspension**

|        |                                                                                                                            |     |
|--------|----------------------------------------------------------------------------------------------------------------------------|-----|
| 4.3.12 | Remove, inspect and install coil springs and spring insulators                                                             | P-2 |
| 4.3.13 | Remove, inspect, and install transverse links, control arms, bushings and mounts                                           | P-2 |
| 4.3.14 | Remove, inspect, and install leaf springs, leaf spring insulators (silencers), shackles, brackets, bushings and mounts     | P-3 |
| 4.3.15 | Remove, inspect, and install strut cartridge or assembly, strut coil spring and insulators (silencers)                     | P-2 |
| 4.3.16 | Inspect, remove and replace shock absorbers                                                                                | P-1 |
| 4.3.17 | Remove, inspect and service or replace front and rear wheel bearings                                                       | P-1 |
| 4.3.18 | Test and diagnose components or electronically controlled suspension systems using a scan tool; determine necessary action | P-3 |

#### **Competency 4.4: Perform wheel alignment diagnosis, adjustment and repair**

##### **Key Indicators:**

|        |                                                                                                                                                       |     |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 4.4.1  | Differentiate between steering and suspension concerns using principles of steering geometry (caste, camber, toe, etc.)                               | P-1 |
| 4.4.2  | Diagnose vehicle wander, drift, pull, hard steering, bump steer, memory steer, torque steer, and steering return concerns; determine necessary action | P-1 |
| 4.4.3  | Perform prealignment inspection; perform necessary action                                                                                             | P-1 |
| 4.4.4  | Measure vehicle riding height; determine necessary action                                                                                             | P-1 |
| 4.4.5  | Check and adjust front and rear wheel camber; perform necessary action                                                                                | P-1 |
| 4.4.6  | Check and adjust caster; perform necessary action                                                                                                     | P-1 |
| 4.4.7  | Check and adjust front wheel toe; adjust as needed                                                                                                    | P-1 |
| 4.4.8  | Center steering wheel                                                                                                                                 | P-1 |
| 4.4.9  | Check toe-out-on-turns (turning radius); determine necessary action                                                                                   | P-2 |
| 4.4.10 | Check steering axis inclination(SAI) and included angle; determine necessary action                                                                   | P-2 |
| 4.4.11 | Check and adjust rear wheel toe                                                                                                                       | P-2 |
| 4.4.12 | Check rear wheel thrust angle; determine necessary action                                                                                             | P-2 |
| 4.4.13 | Check for front wheel setback; determine necessary action                                                                                             | P-2 |
| 4.4.14 | Check front cradle (subframe) alignment; determine necessary action                                                                                   | P-3 |

#### **Competency 4.5: Perform wheel and tire diagnosis and repair**

##### **Key Indicators:**

|        |                                                                             |     |
|--------|-----------------------------------------------------------------------------|-----|
| 4.5.1  | Diagnose tire wear patterns; determine necessary action                     | P-1 |
| 4.5.2  | Inspect tires; check and adjust air pressure                                | P-1 |
| 4.5.3  | Diagnose wheel/tire vibration, shimmy and noise; determine necessary action | P-2 |
| 4.5.4  | Rotate tires according to manufacturer's recommendations                    | P-1 |
| 4.5.5  | Measure wheel, tire, axle and hub runout; determine necessary action        | P-2 |
| 4.5.6  | Diagnose tire pull (lead) problem; determine necessary action               | P-2 |
| 4.5.7  | Balance wheel and tire assembly (static and dynamic)                        | P-1 |
| 4.5.8  | Dismount, inspect, repair and remount tire on wheel                         | P-2 |
| 4.5.9  | Reinstall wheel; torque lugnuts                                             | P-1 |
| 4.5.10 | Inspect and repair tire                                                     | P-2 |

### **Unit 5: Brakes\*\***

**Competency 5.1: Perform general brake system diagnosis****Key Indicators:**

- |       |                                                                                                                                                                  |     |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 5.1.1 | Identify and interpret brake system concern; determine necessary action                                                                                          | P-1 |
| 5.1.2 | Research applicable vehicle and service information such as brake system operation, vehicle service history, service precautions and technical service bulletins | P-1 |
| 5.1.3 | Locate and interpret vehicle and major component identification numbers (VIN, vehicle certification labels, calibration decals)                                  | P-1 |

**Competency 5.2: Perform hydraulic system diagnosis and repair****Key Indicators:**

- |        |                                                                                                                                                                            |     |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 5.2.1  | Diagnosis pressure concerns in the brake system using hydraulic principles (Paschal's Law)                                                                                 | P-1 |
| 5.2.2  | Measure and adjust pedal height                                                                                                                                            | P-2 |
| 5.2.3  | Check master cylinder for internal and external leaks and proper operation; determine necessary action                                                                     | P-2 |
| 5.2.4  | Remove, bench bleed and reinstall master cylinder                                                                                                                          | P-1 |
| 5.2.5  | Diagnose poor stopping, pulling or dragging concerns caused by problems in the hydraulic system; determine necessary action                                                | P-1 |
| 5.2.6  | Inspect brake lines, flexible hoses, and fittings for leaks, dents, kinks, rust, cracks, bulging, or wear; tighten loose fittings and supports; determine necessary action | P-2 |
| 5.2.7  | Fabricate and install brake lines (double flare and ISO types); replace hoses, fittings and supports as needed                                                             | P-2 |
| 5.2.8  | Select, handle, store and install brake fluids to proper level                                                                                                             | P-1 |
| 5.2.9  | Inspect, test, and replace metering (hold-off), proportioning (balance), pressure differential and combination valves                                                      | P-2 |
| 5.2.10 | Inspect, test, replace and adjust height (load) sensing proportioning valve                                                                                                | P-3 |
| 5.2.11 | Inspect, test, and replace components of brake warning light system                                                                                                        | P-3 |
| 5.2.12 | Bleed (manual, pressure, vacuum, or surge) brake system                                                                                                                    | P-1 |
| 5.2.13 | Flush hydraulic system                                                                                                                                                     | P-3 |

**Competency 5.3: Perform drum brake diagnosis and repair****Key Indicators:**

- |       |                                                                                                                                                                                    |     |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 5.3.1 | Diagnose poor stopping, noise, pulling, grabbing, dragging or pedal pulsation concerns; determine necessary action                                                                 | P-1 |
| 5.3.2 | Remove, clean (using proper safety procedures), inspect, and measure brake drums; service or replace as needed                                                                     | P-1 |
| 5.3.3 | Refinish brake drum                                                                                                                                                                | P-1 |
| 5.3.4 | Remove, clean, and inspect brake shoes, springs, pins, clips, levers, adjusters/self-adjusters, other related brake hardware, and backing support plates; lubricate and reassemble | P-1 |
| 5.3.5 | Remove, inspect and install wheel cylinders                                                                                                                                        | P-2 |
| 5.3.6 | Pre-adjust brake shoes and parking brake before installing brake drums or drum/hub assemblies and wheel bearings                                                                   | P-1 |
| 5.3.7 | Install wheel, torque lug nuts and make final checks and adjustments                                                                                                               | P-1 |

**Competency 5.4: Perform disc brake diagnosis and repair****Key Indicators:**

|        |                                                                                                                                                          |     |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 5.4.1  | Diagnose poor stopping, noise, pulling, grabbing, dragging or pedal pulsation concerns; determine necessary action                                       | P-1 |
| 5.4.2  | Remove caliper assembly from mountings; clean and inspect for leaks and damage to caliper housing; determine necessary action                            | P-1 |
| 5.4.3  | Clean and inspect caliper mounting and slides for wear and damage; determine necessary action                                                            | P-1 |
| 5.4.4  | Remove, clean and inspect pads and retaining hardware; determine necessary action                                                                        | P-1 |
| 5.4.5  | Disassemble and clean caliper assembly; inspect parts for wear, rust, scoring and damage; replace seal, boot and damaged or worn parts                   | P-2 |
| 5.4.6  | Reassemble, lubricate and reinstall caliper, pads and related hardware; seat pads and inspect for leaks                                                  | P-1 |
| 5.4.7  | Clean inspect, and measure rotor with a dial indicator and a micrometer; follow manufacturer's recommendations in determining need to machine or replace | P-1 |
| 5.4.8  | Remove and reinstall rotor                                                                                                                               | P-1 |
| 5.4.9  | Refinish rotor according to manufacturers' recommendations                                                                                               | P-1 |
| 5.4.10 | Adjust calipers with integrated parking brake system                                                                                                     | P-3 |
| 5.4.11 | Install wheel, torque lug nuts and make final checks and adjustments                                                                                     | P-1 |

#### **Competency 5.5: Perform power assist unit diagnosis and repair**

##### **Key Indicators:**

|       |                                                                                                                                       |     |
|-------|---------------------------------------------------------------------------------------------------------------------------------------|-----|
| 5.5.1 | Test pedal free travel with and without engine running; check power assist operation                                                  | P-2 |
| 5.5.2 | Check vacuum supply (manifold or auxiliary pump) to vacuum-type power booster                                                         | P-2 |
| 5.5.3 | Inspect the vacuum-type power booster unit for vacuum leaks; inspect the check valve for proper operation; determine necessary action | P-2 |
| 5.5.4 | Inspect and test hydro-boost system and accumulator for leaks and proper operation; determine necessary action                        | P-3 |

#### **Competency 5.6: Perform miscellaneous (i.e., wheel bearings, parking brakes, electrical) diagnosis and repair**

##### **Key Indicators:**

|       |                                                                                                                            |     |
|-------|----------------------------------------------------------------------------------------------------------------------------|-----|
| 5.6.1 | Diagnose wheel bearing noises, wheel shimmy and vibration concerns; determine necessary action                             | P-1 |
| 5.6.2 | Remove, clean, inspect, repack and install wheel bearings and replace seals; install hub and adjust wheel bearings         | P-1 |
| 5.6.3 | Check parking brake cables and components for wear, rusting, binding and corrosion; clean, lubricate and replace as needed | P-2 |
| 5.6.4 | Check parking brake operation; adjust as needed                                                                            | P-1 |
| 5.6.5 | Check operation of parking brake indicator light system                                                                    | P-3 |
| 5.6.6 | Check operation of brake stop light system; determine necessary action                                                     | P-1 |
| 5.6.7 | Replace wheel bearing and race                                                                                             | P-1 |
| 5.6.8 | Inspect and replace wheel studs                                                                                            | P-1 |
| 5.6.9 | Remove and reinstall sealed wheel bearing assembly                                                                         | P-2 |

#### **Competency 5.7: Repair anti-lock brake systems**

##### **Key Indicators:**

|       |                                                                                                                                           |     |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 5.7.1 | Inspect and test Anti-lock Brake System (ABS) components; determine necessary action                                                      | P-1 |
| 5.7.2 | Diagnose poor stopping, wheel lock-up, abnormal pedal feel or pulsation, and noise concerns caused by the ABS; determine necessary action | P-2 |

|       |                                                                                                                                                                                                                                           |     |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 5.7.3 | Diagnose ABS electronic control(s) and components using self-diagnosis and/or recommended test equipment; determine necessary action                                                                                                      | P-1 |
| 5.7.4 | Depressurize high-pressure components of the ABS                                                                                                                                                                                          | P-3 |
| 5.7.5 | Bleed the ABS front and rear hydraulic circuits                                                                                                                                                                                           | P-2 |
| 5.7.6 | Remove and install ABS electrical/electronic and hydraulic components                                                                                                                                                                     | P-3 |
| 5.7.7 | Test, diagnose and service ABS speed sensors, toothed ring (tone wheel), and circuits using a graphing multimeter (GMM/digital storage oscilloscope (DSO) includes output signal, resistance, short to voltage/ground and frequency data) | P-1 |
| 5.7.8 | Diagnose ABS braking concerns caused by vehicle modifications (i.e., tire size, curb height, final drive ratio)                                                                                                                           | P-3 |
| 5.7.9 | Identify traction control system components                                                                                                                                                                                               | P-3 |

## Unit 6: Electrical and Electronic Systems\*\*

### Competency 6.1: Diagnose general electrical systems

#### Key Indicators:

|        |                                                                                                                                                                                    |     |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 6.1.1  | Identify and interpret electrical/electronic system concern; determine necessary action                                                                                            | P-1 |
| 6.1.2  | Research applicable vehicle and service information, such as electrical/electronic system operation, vehicle service history, service precautions, and technical service bulletins | P-1 |
| 6.1.3  | Locate and interpret vehicle and major component identification numbers (VIN, vehicle certification labels, and calibration decals)                                                | P-1 |
| 6.1.4  | Diagnose electrical/electronic integrity of series, parallel and series-parallel circuits using principles of electricity (Ohm's Law)                                              | P-1 |
| 6.1.5  | Use wiring diagrams during diagnosis of electrical circuit problems                                                                                                                | P-1 |
| 6.1.6  | Demonstrate the proper use of a digital multimeter (DMM) during diagnosis of electrical circuit problems                                                                           | P-1 |
| 6.1.7  | Check electrical circuits with a test light; determine necessary action                                                                                                            | P-2 |
| 6.1.8  | Measure source voltage and perform voltage drop tests in electrical/electronic circuits using a voltmeter; determine necessary action                                              | P-1 |
| 6.1.9  | Measure current flow in electrical/electronic circuits and components using an ammeter; determine necessary action                                                                 | P-1 |
| 6.1.10 | Check continuity and measure resistance in electrical/electronic circuits and components using an ohmmeter; determine necessary action                                             | P-1 |
| 6.1.11 | Check electrical circuits using jumper wires; determine necessary action                                                                                                           | P-2 |
| 6.1.12 | Locate shorts, grounds, opens, and resistance problems in electrical/electronic circuits; determine necessary action                                                               | P-1 |
| 6.1.13 | Measure and diagnose the cause(s) of abnormal key-off battery drain; determine necessary action                                                                                    | P-1 |
| 6.1.14 | Inspect and test fusible links, circuit breakers, and fuses; determine necessary action                                                                                            | P-1 |
| 6.1.15 | Inspect and test switches, connectors, relays, and wires of electrical/electronic circuits; perform necessary action                                                               | P-1 |
| 6.1.16 | Repair wiring harnesses and connectors                                                                                                                                             | P-1 |
| 6.1.17 | Perform solder repair of electrical wiring                                                                                                                                         | P-1 |

### Competency 6.2: Perform battery diagnosis and service

#### Key Indicators:

|       |                                                                                                                  |     |
|-------|------------------------------------------------------------------------------------------------------------------|-----|
| 6.2.1 | Perform battery state-of-charge test; determine needed service                                                   | P-1 |
| 6.2.2 | Perform battery capacity test; confirm proper battery capacity for vehicle application; determine needed service | P-1 |
| 6.2.3 | Maintain or restore electronic memory functions                                                                  | P-1 |
| 6.2.4 | Inspect, clean, fill, and replace battery                                                                        | P-2 |

|       |                                                                                                   |     |
|-------|---------------------------------------------------------------------------------------------------|-----|
| 6.2.5 | Perform slow/fast battery charge                                                                  | P-2 |
| 6.2.6 | Inspect and clean battery cables, connectors, clamps, and hold-downs; repair or replace as needed | P-1 |
| 6.2.7 | Start a vehicle using jumper cables and a battery or auxiliary power supply                       | P-1 |

### **Competency 6.3: Perform starting system diagnosis and repair**

#### **Key Indicators:**

|       |                                                                                                               |     |
|-------|---------------------------------------------------------------------------------------------------------------|-----|
| 6.3.1 | Perform starter current draw tests; determine necessary action                                                | P-1 |
| 6.3.2 | Perform starter circuit voltage drop tests; determine necessary action                                        | P-1 |
| 6.3.3 | Inspect and test starter relays and solenoids; replace as needed                                              | P-2 |
| 6.3.4 | Remove and install starter in a vehicle                                                                       | P-1 |
| 6.3.5 | Inspect and test switches, connectors, and wires of starter control circuits; perform necessary action        | P-2 |
| 6.3.6 | Differentiate between electrical and engine mechanical problems that cause a slow-crank or no crank condition | P-2 |

### **Competency 6.4: Perform charging system diagnosis and repair**

#### **Key Indicators:**

|       |                                                                                                                          |     |
|-------|--------------------------------------------------------------------------------------------------------------------------|-----|
| 6.4.1 | Perform charging system output test; determine necessary action                                                          | P-1 |
| 6.4.2 | Diagnose charging system for the cause of undercharge, no-charge, and overcharge conditions                              | P-1 |
| 6.4.3 | Inspect, adjust, or replace generator (alternator) drive belts, pulleys, and tensioners; check pulley and belt alignment | P-2 |
| 6.4.4 | Remove, inspect, and install generator (alternator)                                                                      | P-1 |
| 6.4.5 | Perform charging circuit voltage drop tests; determine necessary action                                                  | P-1 |

### **Competency 6.5: Perform lighting systems diagnosis and repair**

#### **Key Indicators:**

|       |                                                                                                                  |     |
|-------|------------------------------------------------------------------------------------------------------------------|-----|
| 6.5.1 | Diagnose the cause of brighter than normal, intermittent, dim, or no light operation; determine necessary action | P-1 |
| 6.5.2 | Inspect, replace, and aim headlights and bulbs                                                                   | P-2 |
| 6.5.3 | Inspect and diagnose incorrect turn signal or hazard light operation; perform necessary action                   | P-2 |

### **Competency 6.6: Repair gauges, warning devices, and driver information systems**

#### **Key Indicators:**

#### **Diagnosis and Repair**

|       |                                                                                                                                        |     |
|-------|----------------------------------------------------------------------------------------------------------------------------------------|-----|
| 6.6.1 | Inspect and test gauges and gauge sending units for cause of intermittent, high, low, or no gauge readings; determine necessary action | P-1 |
| 6.6.2 | Inspect and test connectors, wires, and printed circuit boards of gauge circuits; determine necessary action                           | P-3 |
| 6.6.3 | Diagnose the cause of incorrect operation or warning devices and other driver information systems; determine necessary action          | P-1 |
| 6.6.4 | Inspect and test sensors, connectors, and wires of electronic instrument circuits; determine necessary action                          | P-2 |

### **Competency 6.7: Perform horn and wiper/washer diagnosis and repair**

**Key Indicators:**

|       |                                                                                                              |     |
|-------|--------------------------------------------------------------------------------------------------------------|-----|
| 6.7.1 | Diagnose incorrect horn operation; perform necessary action                                                  | P-2 |
| 6.7.2 | Diagnose incorrect wiper operation; diagnose wiper speed control and park problems; perform necessary action | P-2 |
| 6.7.3 | Diagnose incorrect windshield washer operation; perform necessary action                                     | P-2 |

**Competency 6.8: Perform accessories diagnosis and repair****Key Indicators:**

|        |                                                                                                                                                                    |     |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 6.8.1  | Diagnose incorrect operation of motor-driven accessory circuits; determine necessary action                                                                        | P-2 |
| 6.8.2  | Diagnose incorrect heated glass operation; determine necessary action                                                                                              | P-3 |
| 6.8.3  | Diagnose incorrect electric lock operation; determine necessary action                                                                                             | P-3 |
| 6.8.4  | Diagnose incorrect operation of cruise control systems; repair as needed                                                                                           | P-3 |
| 6.8.5  | Diagnose supplemental restraint system (SRS) concerns; determine necessary action (Note: Follow manufacturer's safety procedures to prevent accidental deployment) | P-2 |
| 6.8.6  | Disarm and enable the airbag system for vehicle service                                                                                                            | P-1 |
| 6.8.7  | Diagnose radio static and weak, intermittent or no radio reception; determine necessary action                                                                     | P-3 |
| 6.8.8  | Remove and reinstall door panel                                                                                                                                    | P-1 |
| 6.8.9  | Diagnose body electronic system circuits using a scan tool; determine necessary action                                                                             | P-2 |
| 6.8.10 | Check for module communication errors using a scan tool                                                                                                            | P-3 |
| 6.8.11 | Diagnose the cause of false, intermittent or no operation of anti-theft system                                                                                     | P-2 |

**Unit 7: Engine Performance\*\*****Competency 7.1: Perform general engine diagnosis****Key Indicators:**

|        |                                                                                                                                                                                |     |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 7.1.1  | Identify and interpret engine performance concern; determine necessary action                                                                                                  | P-1 |
| 7.1.2  | Research applicable vehicle and service information, such as engine management system operation, vehicle service history, service precautions, and technical service bulletins | P-1 |
| 7.1.3  | Locate and interpret vehicle and major component identification numbers (VIN, vehicle certification labels, and calibration decals)                                            | P-1 |
| 7.1.4  | Inspect engine assembly for fuel, oil, coolant and other leaks; determine necessary action                                                                                     | P-2 |
| 7.1.5  | Diagnose abnormal engine noise or vibration concerns; determine necessary action                                                                                               | P-2 |
| 7.1.6  | Diagnose unusual exhaust color, odor, and sound; determine necessary action                                                                                                    | P-2 |
| 7.1.7  | Perform engine absolute (vacuum/boost) manifold pressure tests; determine necessary action                                                                                     | P-1 |
| 7.1.8  | Perform cylinder power balance test; determine necessary action                                                                                                                | P-1 |
| 7.1.9  | Perform cylinder compression test; determine necessary action                                                                                                                  | P-1 |
| 7.1.10 | Perform cylinder leakage test; determine necessary action                                                                                                                      | P-1 |
| 7.1.11 | Diagnose engine mechanical, electrical, electronic, fuel and ignition concerns with oscilloscope and engine diagnostic equipment; determine necessary action                   | P-1 |
| 7.1.12 | Prepare 4 or 5 gas analyzer; inspect and prepare vehicle for test, and obtain exhaust readings; interpret readings and determine necessary action                              | P-1 |
| 7.1.13 | Verify engine operating temperature; determine necessary action                                                                                                                | P-1 |

|        |                                                                                                                                                                    |     |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 7.1.14 | Perform cooling system pressure tests; check coolant condition; inspect and test radiator, pressure cap, coolant recovery tank and hoses; perform necessary action | P-1 |
| 7.1.15 | Verify correct camshaft timing                                                                                                                                     | P-2 |

#### **Competency 7.2: Perform computerized engine controls diagnosis and repair**

##### **Key Indicators:**

|       |                                                                                                                                                                                                                                                                                     |     |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 7.2.1 | Retrieve and record stored OBD I diagnostic trouble codes; clear codes                                                                                                                                                                                                              | P-2 |
| 7.2.2 | Retrieve and record stored OBD II diagnostic trouble codes; clear codes                                                                                                                                                                                                             | P-1 |
| 7.2.3 | Diagnose the causes of emissions or drivability concerns resulting from failure of computerized engine controls with stored diagnostic trouble codes                                                                                                                                | P-1 |
| 7.2.4 | Diagnose emissions or drivability concerns resulting from failure of computerized engine controls with no stored diagnostic trouble codes; determine necessary action                                                                                                               | P-1 |
| 7.2.5 | Check for module communication errors using a scan tool                                                                                                                                                                                                                             | P-2 |
| 7.2.6 | Inspect and test computerized engine control system sensors, powertrain control module (PCM), actuators, and circuits using a graphing multimeter (GMM)/digital storage oscilloscope (DSO); perform necessary action                                                                | P-1 |
| 7.2.7 | Obtain and interpret scan tool data                                                                                                                                                                                                                                                 | P-1 |
| 7.2.8 | Access and use service information to perform step-by-step diagnosis                                                                                                                                                                                                                | P-1 |
| 7.2.9 | Diagnose drivability and emissions problems resulting from failures of interrelated systems (cruise control, security alarms, suspension controls, traction controls, A/C, automatic transmissions, non-OEM-installed accessories, and similar systems); determine necessary action | P-2 |

#### **Competency 7.3: Perform ignition system diagnosis and repair**

##### **Key Indicators:**

|       |                                                                                                                                                                                                                                                                          |     |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 7.3.1 | Diagnose ignition system related problems such as no-starting, hard starting, engine misfire, poor drivability, spark knock, power loss, poor mileage, and emissions concerns on vehicles with electronic ignition (distributorless) systems; determine necessary action | P-1 |
| 7.3.2 | Diagnose ignition system related problems such as no-starting, hard starting, engine misfire, poor drivability, spark knock, power loss, poor mileage, and emissions concerns on vehicles with distributor ignition (DI) systems; determine necessary action             | P-1 |
| 7.3.3 | Inspect and test ignition primary circuit wiring and components; perform necessary action                                                                                                                                                                                | P-2 |
| 7.3.4 | Inspect and test distributor; perform necessary action                                                                                                                                                                                                                   | P-3 |
| 7.3.5 | Inspect and test ignition system secondary circuit wiring and components; perform necessary action                                                                                                                                                                       | P-2 |
| 7.3.6 | Inspect and test ignition coil(s); perform necessary action                                                                                                                                                                                                              | P-1 |
| 7.3.7 | Check and adjust (where applicable) ignition system timing and timing advance/retard                                                                                                                                                                                     | P-1 |
| 7.3.8 | Inspect and test ignition system pick-up sensor or triggering devices; perform necessary action                                                                                                                                                                          | P-2 |

#### **Competency 7.4: Perform fuel, air induction and exhaust systems diagnosis and repair**

##### **Key Indicators:**

|       |                                                                                                                                                                                                                                                                                                    |     |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 7.4.1 | Diagnose hot or cold no-starting, hard starting, poor drivability, incorrect idle speed, poor idle, flooding, hesitation, surging, engine misfire, power loss, stalling, poor mileage, dieseling, and emissions problems on vehicles with carburetor-type fuel systems; determine necessary action | P-3 |
| 7.4.2 | Diagnose hot or cold no-starting, hard starting, poor drivability, incorrect idle                                                                                                                                                                                                                  | P-1 |

|        |                                                                                                                                                                                                                 |     |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|        | speed, poor idle, flooding, hesitation, surging, engine misfire, power loss, stalling, poor mileage, dieseling, and emissions problems on vehicles with injection-type fuel systems; determine necessary action |     |
| 7.4.3  | Check fuel for contaminants and quality; determine necessary action                                                                                                                                             | P-3 |
| 7.4.4  | Inspect and test mechanical and electrical fuel pumps and pump control systems; perform necessary action                                                                                                        | P-2 |
| 7.4.5  | Replace fuel filters                                                                                                                                                                                            | P-1 |
| 7.4.6  | Inspect and test cold enrichment system and components; perform necessary action                                                                                                                                | P-3 |
| 7.4.7  | Inspect throttle body, air induction system, intake manifold and gaskets for vacuum leaks and/or unmetered air                                                                                                  | P-2 |
| 7.4.8  | Inspect, test, and clean fuel injectors                                                                                                                                                                         | P-2 |
| 7.4.9  | Check idle speed and fuel mixture                                                                                                                                                                               | P-3 |
| 7.4.10 | Adjust idle speed and fuel mixture                                                                                                                                                                              | P-3 |
| 7.4.11 | Inspect the integrity of the exhaust manifold, exhaust pipes, muffler(s), catalytic converter(s), resonator(s), tail pipe(s), and heat shield(s); perform necessary action                                      | P-2 |
| 7.4.12 | Perform exhaust system back-pressure test; determine necessary action                                                                                                                                           | P-1 |
| 7.4.13 | Test the operation of turbocharger/supercharger systems; determine necessary action                                                                                                                             | P-3 |

#### **Competency 7.5: Perform emissions control systems diagnosis and repair**

##### **Key Indicators:**

##### **Positive crankcase ventilation**

|       |                                                                                                                                                               |     |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 7.5.1 | Diagnose oil leaks, emissions, and drivability problems resulting from failure of the positive crankcase ventilation (PCV) system; determine necessary action | P-2 |
| 7.5.2 | Inspect and test positive crankcase ventilation (PCV) filter/breather cap, valve, tubes, orifices, and hoses; perform necessary action                        | P-2 |

##### **Exhaust gas recirculation**

|       |                                                                                                                                                                                |     |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 7.5.3 | Diagnose emissions and drivability problems caused by failure of the exhaust gas recirculation (EGR) system; determine necessary action                                        | P-1 |
| 7.5.4 | Inspect, test, service and replace components of the EGR system, including EGR tubing, exhaust passages, vacuum/pressure controls, filters and hoses; perform necessary action | P-2 |
| 7.5.5 | Inspect and test electrical/electronic sensors, controls, and wiring of exhaust gas recirculation (EGR) systems; perform necessary action                                      | P-2 |

##### **Exhaust gas treatment**

|       |                                                                                                                                                               |     |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 7.5.6 | Diagnose emissions and drivability problems resulting from failure of the secondary air injection and catalytic converter systems; determine necessary action | P-2 |
| 7.5.7 | Inspect and test mechanical components of secondary air injection systems; perform necessary action                                                           | P-3 |
| 7.5.8 | Inspect and test electrical/electronically-operated components and circuits of air injection systems; perform necessary action                                | P-3 |
| 7.5.9 | Inspect and test catalytic converter performance                                                                                                              | P-1 |

##### **Intake air temperature controls**

|        |                                                                                                                                             |     |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 7.5.10 | Diagnose emissions and drivability problems resulting from failure of the intake air temperature control system; determine necessary action | P-3 |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------|-----|

|        |                                                                                                |     |
|--------|------------------------------------------------------------------------------------------------|-----|
| 7.5.11 | Inspect and test components of intake air temperature control system; perform necessary action | P-3 |
|--------|------------------------------------------------------------------------------------------------|-----|

#### **Early fuel evaporation (intake manifold temperature) controls**

|        |                                                                                                                                         |     |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------|-----|
| 7.5.12 | Diagnose emissions and drivability problems resulting from failure of early fuel evaporation control system; determine necessary action | P-3 |
| 7.5.13 | Inspect and test components of early fuel evaporation control system; perform necessary action                                          | P-3 |

#### **Evaporative emissions controls**

|        |                                                                                                                                        |     |
|--------|----------------------------------------------------------------------------------------------------------------------------------------|-----|
| 7.5.14 | Diagnose emissions and drivability problems resulting from failure of evaporative emissions control system; determine necessary action | P-1 |
| 7.5.15 | Inspect and test components and hoses of evaporative emissions control system; perform necessary action                                | P-1 |
| 7.5.16 | Interpret evaporative emission related diagnostic trouble codes (DTCs); determine necessary action                                     | P-1 |

### **Competency 7.6: Perform engine-related service**

#### **Key Indicators:**

|       |                                                                                                                                          |     |
|-------|------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 7.6.1 | Adjust valves on engines with mechanical or hydraulic lifters                                                                            | P-1 |
| 7.6.2 | Remove and replace timing belt; verify correct camshaft timing                                                                           | P-1 |
| 7.6.3 | Remove and replace thermostat                                                                                                            | P-2 |
| 7.6.4 | Inspect and test mechanical/electrical fans, fan clutch, fan shroud/ducting, air dams, and fan control devices; perform necessary action | P-2 |

## **Unit 8: Engine Repair (Optional Unit)**

### **Competency 8.1: Perform general engine diagnosis; removal and reinstallation (R&R)**

#### **Key Indicators:**

|        |                                                                                                                                                                       |     |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 8.1.1  | Identify and interpret engine concern; determine necessary action                                                                                                     | P-1 |
| 8.1.2  | Research applicable vehicle and service information, such as internal engine operation, vehicle service history, service precautions and technical service bulletins  | P-1 |
| 8.1.3  | Locate and interpret vehicle and major component identification numbers (VIN, vehicle certification labels and calibration decals)                                    | P-1 |
| 8.1.4  | Inspect engine assembly for fuel, oil, coolant and other leaks; determine necessary action                                                                            | P-1 |
| 8.1.5  | Diagnose engine noises and vibrations; determine necessary action                                                                                                     | P-2 |
| 8.1.6  | Diagnose the cause of excessive oil consumption, unusual engine exhaust color, odor, and sound; determine necessary action                                            | P-2 |
| 8.1.7  | Perform engine vacuum tests; determine necessary action                                                                                                               | P-1 |
| 8.1.8  | Perform cylinder power balance tests; determine necessary action                                                                                                      | P-1 |
| 8.1.9  | Perform cylinder compression tests; determine necessary action                                                                                                        | P-1 |
| 8.1.10 | Perform cylinder leakage tests; determine necessary action                                                                                                            | P-1 |
| 8.1.11 | Remove and install engine in a late model front-wheel drive vehicle (OBDI or newer); reconnect all attaching components and restore the vehicle to running condition  | P-1 |
| 8.1.12 | Remove and reinstall engine in a late model rear-wheel drive vehicle (OBDI or newer); reconnect all attaching components and restore the vehicle to running condition | P-3 |

### **Competency 8.2: Perform cylinder head and valve train diagnosis and repair**

#### **Key Indicators:**

|        |                                                                                                                                                                   |     |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 8.2.1  | Remove cylinder head(s); visually inspect cylinder head(s) for cracks; check gasket surface areas for warpage and leakage; check passage condition                | P-2 |
| 8.2.2  | Install cylinder heads and gaskets; tighten according to manufacturers' specifications and procedures                                                             | P-1 |
| 8.2.3  | Inspect and test valve springs for squareness, pressure, and free height comparison; determine necessary action                                                   | P-2 |
| 8.2.4  | Replace valve stem seals on an assembled engine; inspect valve spring retainers, locks, and valve grooves; determine necessary action                             | P-2 |
| 8.2.5  | Inspect valve guides for wear; check valve and stem-to-guide clearance; determine necessary action                                                                | P-3 |
| 8.2.6  | Inspect valves and valve seats; determine necessary action necessary action                                                                                       | P-3 |
| 8.2.7  | Check valve face-to-seat contact and valve seat concentricity (runout); determine necessary action                                                                | P-3 |
| 8.2.8  | Check valve spring assembled height and valve stem height; determine necessary action                                                                             | P-3 |
| 8.2.9  | Inspect pushrods, rocker arms, rocker arm pivots and shafts for wear, bending, cracks, looseness, and blocked oil passages (orifices); determine necessary action | P-2 |
| 8.2.10 | Inspect hydraulic or mechanical lifters; determine necessary action                                                                                               | P-2 |
| 8.2.11 | Adjust valves (mechanical or hydraulic lifters)                                                                                                                   | P-1 |
| 8.2.12 | Inspect camshaft drives (including gear wear and backlash, sprocket and chain wear); determine necessary action                                                   | P-2 |
| 8.2.13 | Inspect and replace timing belts (chains), overhead camdrive sprockets, and tensioners; check belt tension; adjust as necessary                                   | P-1 |
| 8.2.14 | Inspect camshaft for runout, journal wear and lobe wear                                                                                                           | P-2 |
| 8.2.15 | Inspect camshaft-bearing surface for wear, damage, out-of-round and alignment; determine necessary action                                                         | P-3 |
| 8.2.16 | Establish camshaft(s) timing and cam sensor indexing according to manufacturers' specifications and procedures                                                    | P-1 |

### **Competency 8.3: Perform engine block assembly diagnosis and repair**

#### **Key Indicators:**

|       |                                                                                                                                                                                                                                                                                               |     |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 8.3.1 | Disassemble engine block; clean and prepare components for inspection and reassembly                                                                                                                                                                                                          | P-2 |
| 8.3.2 | Inspect engine block for visible cracks, passage condition, core and gallery plug condition, and surface warpage; determine necessary action                                                                                                                                                  | P-2 |
| 8.3.3 | Inspect internal and external threads; restore as needed (includes installing thread inserts)                                                                                                                                                                                                 | P-2 |
| 8.3.4 | Inspect and measure cylinder walls for damage, wear, and ridges; determine necessary action                                                                                                                                                                                                   | P-2 |
| 8.3.5 | Deglaze and clean cylinder walls                                                                                                                                                                                                                                                              | P-2 |
| 8.3.6 | Inspect and measure camshaft bearing for wear, damage, out-of-round, and alignment; determine necessary action                                                                                                                                                                                | P-3 |
| 8.3.7 | Inspect crankshaft for end play, straightness, journal damage, keyway damage, thrust flange and sealing surface condition, and visual surface cracks; check oil passage condition, measure journal wear; check crankshaft sensor reluctor ring (where applicable); determine necessary action | P-2 |
| 8.3.8 | Inspect and measure main and connecting rod bearings for damage, clearance, and end play; determine necessary action (includes the proper selection of bearings)                                                                                                                              | P-2 |

|        |                                                                                                                                                                                                                    |     |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 8.3.9  | Identify piston and bearing wear patterns that indicate connecting rod alignment and main bearing bore problems; inspect rod alignment and bearing bore problems; inspect rod alignment and bearing bore condition | P-3 |
| 8.3.10 | Inspect and measure pistons; determine necessary action                                                                                                                                                            |     |
| 8.3.11 | Remove and replace piston pin                                                                                                                                                                                      | P-3 |
| 8.3.12 | Inspect, measure, and install piston rings                                                                                                                                                                         | P-1 |
| 8.3.13 | Inspect auxiliary (balance, intermediate, idler, counterbalance or silencer) shaft(s); inspect shaft(s) and support bearings for damage and wear; determine necessary action; reinstall and time                   | P-2 |
| 8.3.14 | Inspect or replace crankshaft vibration damper (harmonic balancer)                                                                                                                                                 | P-3 |
| 8.3.15 | Assemble the engine using gaskets, seals, and formed-in-place (tube-applied) sealants, thread sealers, etc. according to manufacturer's specifications                                                             | P-2 |

#### **Competency 8.4: Perform lubrication and cooling systems diagnosis and repair**

##### **Key Indicators:**

|        |                                                                                                                                    |     |
|--------|------------------------------------------------------------------------------------------------------------------------------------|-----|
| 8.4.1  | Perform oil pressure tests; determine necessary action                                                                             | P-1 |
| 8.4.2  | Inspect oil pump gears or rotors, housing, pressure relief devices, and pump drive; perform necessary action                       | P-2 |
| 8.4.3  | Perform cooling system, cap, and recovery system tests (pressure, combustion leakage, and temperature); determine necessary action | P-1 |
| 8.4.4  | Inspect, replace, and adjust drive belts, tensioners, and pulleys; check pulley and belt alignment                                 | P-1 |
| 8.4.5  | Inspect and replace engine cooling and heater system hoses                                                                         | P-2 |
| 8.4.6  | Inspect, test, and replace thermostat and housing                                                                                  | P-2 |
| 8.4.7  | Test coolant; drain and recover coolant; flush and refill cooling system with recommended coolant; bleed air as required           | P-1 |
| 8.4.8  | Inspect, test, remove, and replace water pump                                                                                      | P-1 |
| 8.4.9  | Remove and replace radiator                                                                                                        | P-2 |
| 8.4.10 | Inspect, and test fan(s) (electrical or mechanical), fan clutch, fan shroud, and air dams                                          | P-2 |
| 8.4.11 | Inspect auxiliary oil coolers; determine necessary action                                                                          | P-3 |
| 8.4.12 | Inspect, test, and replace oil temperature and pressure switches and sensors                                                       | P-2 |
| 8.4.13 | Perform oil and filter change                                                                                                      | P-1 |

### **Unit 9: Automatic Transmission and Transaxle (Optional Unit)**

#### **Competency 9.1: Perform general transmission and transaxle diagnosis**

##### **Key Indicators:**

|       |                                                                                                                                                                                    |     |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 9.1.1 | Identify and interpret transmission concerns; assure proper engine operation using scan tool; determine necessary action                                                           | P-1 |
| 9.1.2 | Research applicable vehicle and service information, such as transmission/transaxle system operation, vehicle service history, service precautions and technical service bulletins | P-1 |
| 9.1.3 | Locate and interpret vehicle and major component identification numbers (VIN, vehicle certification labels and calibration decals)                                                 | P-1 |
| 9.1.4 | Diagnose fluid usage, level and condition concerns; determine necessary action                                                                                                     | P-1 |
| 9.1.5 | Perform pressure tests; determine necessary action                                                                                                                                 | P-1 |
| 9.1.6 | Perform stall test; determine necessary action                                                                                                                                     | P-2 |
| 9.1.7 | Perform lock-up converter system tests; determine necessary action                                                                                                                 | P-1 |
| 9.1.8 | Diagnose electronic, mechanical, hydraulic, vacuum control system concerns;                                                                                                        | P-1 |

|        |                                                                                                                                      |     |
|--------|--------------------------------------------------------------------------------------------------------------------------------------|-----|
|        | determine necessary action                                                                                                           |     |
| 9.1.9  | Diagnose noise and vibration concerns; determine necessary action                                                                    | P-2 |
| 9.1.10 | Diagnose transmission/transaxle gear reduction/multiplication concerns using driving, driven and held member (power flow) principles | P-1 |

#### **Competency 9.2: Perform transmission and transaxle maintenance and adjustment**

##### **Key Indicators:**

|       |                                                                                                                                                                       |     |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 9.2.1 | Inspect, adjust, or replace throttle (TV) linkages or cables, manual shift linkages or cables; transmission range sensor; check gear select indicator (as applicable) | P-1 |
| 9.2.2 | Service transmission; perform visual inspection; replace fluids and filters                                                                                           | P-1 |

#### **Competency 9.3: Perform in-vehicle transmission and transaxle repair**

##### **Key Indicators:**

|       |                                                                                                             |     |
|-------|-------------------------------------------------------------------------------------------------------------|-----|
| 9.3.1 | Inspect, adjust, or replace (as applicable) vacuum modulator; inspect and repair or replace lines and hoses | P-3 |
| 9.3.2 | Inspect, repair, and replace governor assembly                                                              | P-3 |
| 9.3.3 | Inspect and replace external seals and gaskets                                                              | P-2 |
| 9.3.4 | Inspect extension housing, bushings and seals; perform necessary action                                     | P-3 |
| 9.3.5 | Inspect, leak test, flush, and replace cooler, lines, and fittings                                          | P-2 |
| 9.3.6 | Inspect and replace speedometer drive gear, driven gear, vehicle speed sensor (VSS), and retainers          | P-2 |
| 9.3.7 | Diagnose electronic transmission control systems using a scan tool; determine necessary action              | P-1 |
| 9.3.8 | Inspect, replace, and align powertrain mounts                                                               | P-1 |
| 9.3.9 | Inspect, replace and align powertrain mounts                                                                | P-3 |

#### **Competency 9.4: Perform off-vehicle transmission and transaxle repair**

##### **Key Indicators:**

##### **Removal, disassembly, and reinstallation**

|       |                                                                                                                                                                          |     |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 9.4.1 | Remove and reinstall transmission and torque converter (rear-wheel drive)                                                                                                | P-2 |
| 9.4.2 | Remove and reinstall transaxle and torque converter assembly                                                                                                             | P-1 |
| 9.4.3 | Disassemble, clean, and inspect transmission/transaxle                                                                                                                   | P-1 |
| 9.4.4 | Inspect, measure, clean, and replace valve body (includes surfaces and bores, springs, valves, sleeves, retainers, brackets, check-balls, screens, spacers, and gaskets) | P-2 |
| 9.4.5 | Inspect servo bore, piston, seals, pin, spring, and retainers; determine necessary action                                                                                | P-3 |
| 9.4.6 | Inspect accumulator bore, piston, seals, spring, and retainer; determine necessary action                                                                                | P-3 |
| 9.4.7 | Assemble transmission/transaxle                                                                                                                                          | P-1 |

##### **Oil pump and converter**

|        |                                                                                      |     |
|--------|--------------------------------------------------------------------------------------|-----|
| 9.4.8  | Inspect converter flex plate, attaching parts, pilot, and pump drive, and seal areas | P-2 |
| 9.4.9  | Measure torque converter endplay and check for interference; check stator clutch     | P-2 |
| 9.4.10 | Inspect, measure, and replace oil pump assembly and components                       | P-3 |
| 9.4.11 | Check torque converter and transmission cooling system for contamination             | P-1 |

### **Gear train, shafts, bushings and case**

|        |                                                                                                                                                 |     |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 9.4.12 | Measure endplay or preload; determine necessary action                                                                                          | P-1 |
| 9.4.13 | Inspect oil delivery seal rings, ring grooves, and sealing surface areas                                                                        | P-2 |
| 9.4.14 | Inspect oil delivery seal rings, ring grooves, and sealing surface areas                                                                        | P-2 |
| 9.4.15 | Inspect bushings; replace as needed                                                                                                             | P-2 |
| 9.4.16 | Inspect and measure planetary gear assembly (includes sun, ring gear, thrust washers, planetary gears, and carrier assembly); replace as needed | P-2 |
| 9.4.17 | Inspect case bores, passages, bushings, vents, and mating surfaces; determine necessary action                                                  | P-2 |
| 9.4.18 | Inspect transaxle drive, link chains, sprockets, gears, bearings, and bushings; perform necessary action                                        | P-2 |
| 9.4.19 | Inspect, measure, repair, adjust, or replace transaxle final drive components                                                                   | P-2 |
| 9.4.20 | Inspect and reinstall parking pawl, shaft, spring, and retainer; determine necessary action                                                     | P-3 |

### **Friction and reaction units**

|        |                                                                                                                                   |     |
|--------|-----------------------------------------------------------------------------------------------------------------------------------|-----|
| 9.4.21 | Inspect clutch drum, piston, check-balls, springs, retainers, seals, and friction and pressure plates; determine necessary action | P-2 |
| 9.4.22 | Measure clutch pack clearance; determine necessary action                                                                         | P-1 |
| 9.4.23 | Air test operation of clutch and servo assemblies                                                                                 | P-1 |
| 9.4.24 | Inspect roller and sprag clutch, races, rollers, sprags, springs, cages, and retainers; replace as needed                         | P-1 |
| 9.4.25 | Inspect bands and drums; adjust or replace as needed                                                                              | P-3 |

## **Unit 10: Manual Drive Train and Axles (Optional Unit)**

### **Competency 10.1: Perform general drive train diagnosis**

#### **Key Indicators:**

|        |                                                                                                                                                                          |     |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 10.1.1 | Identify and interpret drive train concern; determine necessary action                                                                                                   | P-1 |
| 10.1.2 | Research applicable vehicle and service information, such as drive train system operation, vehicle service history, service precautions, and technical service bulletins | P-1 |
| 10.1.3 | Locate and interpret vehicle and major component identification numbers (VIN, vehicle certification labels, calibration decals)                                          | P-1 |
| 10.1.4 | Diagnose fluid usage, level, and condition concerns; determine necessary action                                                                                          | P-1 |
| 10.1.5 | Drain and fill manual transmission/transaxle and final drive unit                                                                                                        | P-2 |

### **Competency 10.2: Perform clutch diagnosis and repair**

#### **Key Indicators:**

|        |                                                                                                                                        |     |
|--------|----------------------------------------------------------------------------------------------------------------------------------------|-----|
| 10.2.1 | Diagnose clutch noise, binding, slippage, pulsation, and chatter; determine necessary action                                           | P-1 |
| 10.2.2 | Inspect clutch pedal linkage, cables, automatic adjuster mechanisms, brackets, bushings, pivots, and springs; perform necessary action | P-1 |
| 10.2.3 | Inspect hydraulic clutch slave and master cylinders, lines, and hoses; perform necessary action                                        | P-1 |
| 10.2.4 | Inspect release (throw-out) bearing, lever, and pivot; determine necessary action                                                      | P-1 |
| 10.2.5 | Inspect and replace clutch pressure plate assembly and clutch disc                                                                     | P-1 |
| 10.2.6 | Bleed clutch hydraulic system                                                                                                          | P-1 |
| 10.2.7 | Inspect, remove, or replace crankshaft pilot bearing or bushing (as applicable)                                                        | P-1 |

|         |                                                                                                                                                |     |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 10.2.8  | Inspect flywheel and ring gear for wear and cracks, measure runout; determine necessary action                                                 | P-1 |
| 10.2.9  | Inspect engine block, clutch (bell) housing, and transmission/transaxle case mating surfaces; and alignment dowels; determine necessary action | P-3 |
| 10.2.10 | Measure flywheel-to-block runout and crankshaft endplay; determine necessary action                                                            | P-3 |

### **Competency 10.3: Perform transmission/transaxle diagnosis and repair**

#### **Key Indicators:**

|         |                                                                                                                                                                  |     |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 10.3.1  | Remove and reinstall transmission/transaxle                                                                                                                      | P-1 |
| 10.3.2  | Disassemble, clean, and reassemble transmission/transaxle components                                                                                             | P-2 |
| 10.3.3  | Inspect transmission/transaxle case, extension housing, case-mating surfaces, bores, bushings, and vents; perform necessary action                               | P-3 |
| 10.3.4  | Diagnose noise, hard shifting, jumping out of gear, and fluid leakage concerns; determine necessary action                                                       | P-2 |
| 10.3.5  | Inspect, adjust, and reinstall shift linkages, brackets, bushings, cables, pivots, and levers                                                                    | P-2 |
| 10.3.6  | Inspect and reinstall powertrain mounts                                                                                                                          | P-3 |
| 10.3.7  | Inspect and replace gaskets, seals, and sealants; inspect sealing surfaces                                                                                       | P-2 |
| 10.3.8  | Remove and replace transaxle final drive                                                                                                                         | P-3 |
| 10.3.9  | Inspect, adjust, and reinstall shift cover, forks, levers, grommets, shafts, sleeves, detent mechanism, interlocks, and springs                                  | P-2 |
| 10.3.10 | Measure endplay or preload (shim or spacer selection procedure) on transmission/transaxle shafts; perform necessary action                                       | P-1 |
| 10.3.11 | Inspect and reinstall synchronizer hub, sleeve, keys (inserts), springs, and blocking rings                                                                      | P-2 |
| 10.3.12 | Inspect and reinstall speedometer drive gear, driven gear, vehicle speed sensor (VSS), and retainers                                                             | P-2 |
| 10.3.13 | Diagnose transaxle final drive assembly noise and vibration concerns; determine necessary action                                                                 | P-3 |
| 10.3.14 | Remove, inspect, measure adjust, and reinstall transaxle final drive pinion gears (spiders), shaft, side gears, side bearings, thrust washers, and case assembly | P-2 |
| 10.3.15 | Inspect lubrication devices (oil pump or slingers); perform necessary action                                                                                     | P-3 |
| 10.3.16 | Inspect, test and replace transmission/transaxle sensors and switches                                                                                            | P-1 |

### **Competency 10.4: Repair drive shaft and half shaft, universal and constant-velocity (CV) Joint Diagnosis and Repair**

#### **Key Indicators:**

|        |                                                                                                |     |
|--------|------------------------------------------------------------------------------------------------|-----|
| 10.4.1 | Diagnose constant-velocity (CV) joint noise and vibration concerns; determine necessary action | P-1 |
| 10.4.2 | Diagnose universal joint noise and vibration concerns; perform necessary action                | P-1 |
| 10.4.3 | Replace front drive (FWD) front wheel bearing                                                  | P-2 |
| 10.4.4 | Inspect, service, and replace shafts, yokes, boots, CV, and universal joints                   | P-1 |
| 10.4.5 | Inspect, service, and replace shaft center support bearings                                    | P-3 |
| 10.4.6 | Check shaft balance; measure shaft runout; measure and adjust driveline angles                 | P-2 |

### **Competency 10.5: Perform drive axle diagnosis and repair**

#### **Key Indicators:**

|        |                                                                   |     |
|--------|-------------------------------------------------------------------|-----|
| 10.5.1 | Diagnose noise and vibration concerns; determine necessary action | P-2 |
| 10.5.2 | Diagnose fluid leakage concerns; determine necessary action       | P-2 |

|         |                                                                                                                                                                        |     |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 10.5.3  | Inspect and service companion flange and pinion seal; measure companion flange runout                                                                                  | P-2 |
| 10.5.4  | Inspect ring gear and measure runout; determine necessary action                                                                                                       | P-2 |
| 10.5.6  | Measure and adjust drive pinion depth                                                                                                                                  | P-2 |
| 10.5.7  | Measure and adjust drive pinion bearing preload                                                                                                                        | P-1 |
| 10.5.8  | Measure and adjust side bearing preload and ring and pinion gear total backlash and backlash variation on a differential carrier assembly (threaded cup or shim types) | P-2 |
| 10.5.9  | Check ring and pinion tooth contact patterns; perform necessary action                                                                                                 | P-1 |
| 10.5.10 | Disassemble, inspect, measure, and adjust or replace differential pinion gears (spiders), shaft, side gears, side bearings, thrust washers, and case                   | P-2 |
| 10.5.11 | Reassemble and reinstall differential case assembly; measure runout; determine necessary action                                                                        | P-2 |

#### **Limited Slip Differential**

|         |                                                                            |     |
|---------|----------------------------------------------------------------------------|-----|
| 10.5.12 | Diagnose noise, slippage, and chatter concerns; determine necessary action | P-3 |
| 10.5.13 | Inspect and flush differential housing; refill with correct lubricant      | P-2 |
| 10.5.14 | Inspect and reinstall clutch (cone or plate) components                    | P-3 |
| 10.5.15 | Measure rotating torque; determine necessary action                        | P-3 |

#### **Repair Drive Axle Shaft**

|         |                                                                                                                              |     |
|---------|------------------------------------------------------------------------------------------------------------------------------|-----|
| 10.5.16 | Diagnose drive axle shafts, bearings, and seals for noise, vibration, and fluid leakage concerns; determine necessary action | P-2 |
| 10.5.17 | Inspect and replace drive axle shaft wheel studs                                                                             | P-3 |
| 10.5.18 | Remove and replace drive axle shafts                                                                                         | P-1 |
| 10.5.19 | Inspect and replace drive axle shaft seals, bearings, and retainers                                                          | P-2 |
| 10.5.20 | Measure drive axle flange runout and shaft endplay; determine necessary action                                               | P-2 |

### **Competency 10.6: Perform four-wheel drive/all-wheel drive component diagnosis and repair**

#### **Key Indicators:**

|        |                                                                                                                            |     |
|--------|----------------------------------------------------------------------------------------------------------------------------|-----|
| 10.6.1 | Diagnose noise, vibration, and unusual steering concerns; determine necessary action                                       | P-3 |
| 10.6.2 | Inspect, adjust, and repair shifting controls (mechanical, electrical, and vacuum), bushings, mounts, levers, and brackets | P-3 |
| 10.6.3 | Remove and reinstall transfer case                                                                                         | P-3 |
| 10.6.4 | Disassemble, service, and reassemble transfer case and components                                                          | P-3 |
| 10.6.5 | Inspect front-wheel bearings and locking hubs; perform necessary action                                                    | P-3 |
| 10.6.6 | Check drive assembly seals and vents; check lube level                                                                     | P-3 |
| 10.6.7 | Diagnose test, adjust, and replace electrical/electronic components of four-wheel drive system                             | P-3 |

## **Unit 11: Heating and Air Conditioning (Optional Unit)**

### **Competency 11.1: Perform A/C system diagnosis and repair**

#### **Key Indicators:**

|        |                                                                                                                                                                                           |     |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 11.1.1 | Identify and interpret heating and air conditioning concern; determine necessary action                                                                                                   | P-1 |
| 11.1.2 | Research applicable vehicle and service information, such as heating and air conditioning system operation, vehicle service history, service precautions, and technical service bulletins | P-1 |

|        |                                                                                                                                |     |
|--------|--------------------------------------------------------------------------------------------------------------------------------|-----|
| 11.1.3 | Locate and interpret vehicle and major component identification number (VIN, vehicle certification labels, calibration decals) | P-1 |
| 11.1.4 | Perform test A/C system; diagnose A/C system malfunctions using principles of refrigeration                                    | P-1 |
| 11.1.5 | Diagnose unusual operating noises in the A/C system; determine necessary action                                                | P-2 |
| 11.1.6 | Identify refrigerants type; conduct a performance test of the A/C system; determine necessary action                           | P-1 |
| 11.1.7 | Leak test A/C system; determine necessary action                                                                               | P-1 |
| 11.1.8 | Inspect the condition of discharged oil; determine necessary action                                                            | P-2 |
| 11.1.9 | Determine recommended oil for system application                                                                               | P-1 |

**Competency 11.2: Perform refrigeration system component diagnosis and repair**

**Key Indicators:**

**Compressor and clutch**

|        |                                                                                                                                                        |     |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 11.2.1 | Diagnose A/C system conditions that cause the protection devices (pressure, thermal and PCM) to interrupt system operation; determine necessary action | P-2 |
| 11.2.2 | Inspect A/C compressor drive belts; determine necessary action                                                                                         | P-2 |
| 11.2.3 | Inspect, test, and replace A/C compressor or assembly                                                                                                  | P-2 |
| 11.2.4 | Remove and replace A/C compressor and mountings measure oil quantity; determine necessary action                                                       | P-1 |

**Evaporator, condenser, and related components**

|         |                                                                                                                              |     |
|---------|------------------------------------------------------------------------------------------------------------------------------|-----|
| 11.2.5  | Determine need for A/C system filter; perform necessary action                                                               | P-3 |
| 11.2.6  | Remove and inspect A/C system mufflers, hoses, lines, fittings, o-rings, seals, and service valves; perform necessary action | P-2 |
| 11.2.7  | Inspect a/c condenser for airflow restrictions; perform necessary action                                                     | P-1 |
| 11.2.8  | Remove and install receiver/drier or accumulator/drier, measure oil quantity; determine necessary action                     | P-1 |
| 11.2.9  | Remove and install expansion valve or orifice (expansion) tube                                                               | P-2 |
| 11.2.10 | Inspect evaporator housing water drain; perform necessary action                                                             | P-3 |
| 11.2.11 | Remove and reinstall evaporator; measure oil quantity; determine necessary action                                            | P-3 |
| 11.2.12 | Remove and reinstall condenser; measure oil quantity; determine necessary action                                             | P-3 |

**Competency 11.3: Perform heating, ventilation, and engine cooling systems diagnosis and repair**

**Key Indicators:**

|        |                                                                                                                                    |     |
|--------|------------------------------------------------------------------------------------------------------------------------------------|-----|
| 11.3.1 | Diagnose temperature control problems in the heater/ventilation system; determine necessary action                                 | P-2 |
| 11.3.2 | Perform cooling system, cap, and recovery system tests (pressure, combustion leakage, and temperature); determine necessary action | P-1 |
| 11.3.3 | Inspect engine cooling and heater system hoses and belts; perform necessary action                                                 | P-1 |
| 11.3.4 | Inspect, test, and replace thermostat and housing                                                                                  | P-1 |
| 11.3.5 | Determine coolant condition; drain and recover coolant                                                                             | P-1 |
| 11.3.6 | Flush system; refill system with recommended coolant; bleed system (follow local disposal guidelines)                              | P-1 |
| 11.3.7 | Inspect and test fan, fan clutch, fan shroud, and air dams; perform necessary action                                               | P-1 |
| 11.3.8 | Inspect and test electrical fan control system and circuits; determine necessary action                                            | P-1 |

- |         |                                                                    |     |
|---------|--------------------------------------------------------------------|-----|
| 11.3.9  | Inspect and test heater control valve(s); perform necessary action | P-2 |
| 11.3.10 | Remove and reinstall heater core                                   | P-3 |

**Competency 11.4: Perform operating systems and related controls diagnosis and repair**

**Key Indicators:**

- |        |                                                                                                                                                           |     |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 11.4.1 | Diagnose failures in the electrical controls of heating, ventilation, and A/C (HVAC) systems; determine necessary action                                  | P-1 |
| 11.4.2 | Inspect and test A/C heater-blower, motors, resistors, switches, relays, wiring, and protection devices; perform necessary action                         | P-2 |
| 11.4.3 | Test and diagnose A/C compressor clutch control systems; determine necessary action                                                                       | P-1 |
| 11.4.4 | Diagnose malfunctions in the vacuum and mechanical components and controls of the heating, ventilation, and A/C (HVAC) system; determine necessary action | P-3 |
| 11.4.5 | Inspect and test A/C heater control panel assembly; determine necessary action                                                                            | P-3 |
| 11.4.6 | Inspect and test A/C heater control cables and linkages; perform necessary action                                                                         | P-3 |
| 11.4.7 | Inspect and test A/C heater ducts, door, hoses, and outlets; perform necessary action                                                                     | P-3 |
| 11.4.8 | Check operation of automatic and semi-automatic heating, ventilation, and air-conditioning (HVAC) control systems; determine necessary action             | P-3 |

**Competency 11.5: Repair refrigerant recovery, recycling and handling**

**Key Indicators:**

- |        |                                                                                                       |     |
|--------|-------------------------------------------------------------------------------------------------------|-----|
| 11.5.1 | Perform correct operation and maintenance of refrigerant handling equipment                           | P-1 |
| 11.5.2 | Identify (by label application or use of a refrigerant identifier) and recover A/C system refrigerant | P-1 |
| 11.5.3 | Recycle refrigerant (in accordance with EPA and OSHA guidelines)                                      | P-1 |
| 11.5.4 | Label and store refrigerant                                                                           | P-1 |
| 11.5.5 | Test recycled and refrigerant for non-condensable gases                                               | P-1 |
| 11.5.6 | Evacuate and charge A/C system                                                                        | P-1 |

**\*\*Required by NATEF for ASE program certification in State of Ohio**

**\*\*\*NATEF/ASE certification requires passing a percentage of competencies in each level (i.e., P-1 95%, P-2 80%, P-3 50%)**

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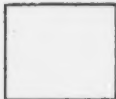


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